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AIR WEATHER SERVICE

RADIOSONDE DEW-POINT ACCURACIES 40°C TO -40°C

By
Lloyd V. Mitchell

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PREFACE

At the request of Headquarters 6th Weather Wing, ETAC computed the root-mean-square (RMS) dew-point accuracies to -40°C as measured by radiosonde equipment. This information was required by the Aeronautical Systems Division, Air Force Systems Command.

In most of the literature, accuracies for radiosonde-measured atmospheric moisture are expressed in terms of relative humidity, i.e., the percent of saturation. This report presents the radiosonde-measured atmospheric moisture accuracies in terms of dew point, i.e., saturation temperature. The dew-point RMS errors are presented in tables which resulted from the computations and in nomograms for ready use. A table and a nomogram are included for temperatures between 0°C and 40°C and another of each for temperatures between -40°C and 0°C. Dew-point accuracies are least for high temperatures and low dew points and greatest for low temperatures and high dew points in each temperature group, viz., 0°C to 40°C and -40°C to 0°C.

This report will aid meteorologists, engineers, and others who require knowledge of the accuracies of radiosonde-measured dew points.

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1 August 1967

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TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

RADIOSONDE DEW-POINT ACCURACIES 40°C TO -40°C

SECTION A — INTRODUCTION

Accuracies of radiosonde-measured data have been of interest to meteorologists for several years. Air Weather Service's interest is exemplified in AWSTR 105-133 [1], published in 1955. This report summarized the best available information at that time relative to the accuracy of radiosonde data as well as listing references of previous studies and tests.

More recently, this interest has expanded to include more than the meteorologists who are engaged in analyzing maps and charts containing radiosonde data. For example, engineers are using radiosonde data as a standard for checking the accuracy of aircraft-mounted meteorological sensors. Also, atmospheric scientists who are concerned with meteorological data from rocket-launched sensors are vitally interested in the radiosonde-data accuracies because pressures and densities above radiosonde altitudes are computed using the 80,000-foot radiosonde data as a base. The Meteorological Working Group, Inter-Range Instrumentation Group (MWG-IRIG) [2] has published the accuracies of surface and upper-air meteorological equipments.

Accuracies of moisture measurements are given in terms of relative humidity in current publications [1], [2], [3]. The accuracy (root-mean-square [RMS] error) for radiosonde-measured relative humidity is 5% for temperatures above 0°C, 10% for temperatures 0°C to -40°C, and questionable for temperatures below -40°C [2]. This error is plus-and-minus the reported relative humidity; i.e., if the relative humidity is reported as 80% at a temperature of 10°C, the relative humidity is from 75 to 85% [6].

Most of the scheduled radiosonde observations in the United States are made by the Environmental Science Services Administration's (ESSA) Weather Bureau. Other agencies, including the USAF, make radiosonde observations as required for special purposes. Although there are slight differences in the radiosonde used by the ESSA and the one used by the USAF, the accuracies are comparable [3], [4]. Therefore, the accuracies presented in this report are applicable to radiosondes currently used by the U.S. agencies [3].

SECTION B — COMPUTATIONS

Since moisture accuracies for the radiosonde are given with respect to

relative humidity, dew-point accuracies are determined by making computations which convert the relative-humidity accuracies into dew-point accuracies. Relative humidity, R, is expressed by ([5] p. 11):

$$(1) \qquad R = (e/e_s) \times 100$$

where e = vapor pressure (mb).
e_s = saturation vapor pressure (mb).
100 = constant required to express R as a percent.

The saturation vapor pressure over water, for example, is expressed by ([5] p. 9):

$$(2) \qquad e_s = (6.11)10^{at/(b+t)}$$

where t = ambient (dry bulb) temperature (°C).
a and b = constants, 7.5 and 237.3°, respectively.

Similarly, the vapor pressure, e, is expressed by:

$$(3) \qquad e = (6.11)10^{aT/(b+T)}$$

where T = dew-point temperature (°C).
a and b = the same values as in Equation (2).

In order to compute the dew-point temperature from relative humidity, it is necessary to express the dew point as a function of temperature, t, and relative humidity, R. Substituting Equations (2) and (3) into Equation (1), we get

$$(4) \qquad R = 100\left[\frac{(6.11)10^{aT/(b+T)}}{(6.11)10^{at/(b+t)}}\right]$$

which reduces to

$$(5) \qquad R = 100\left[\frac{10^{aT/(b+T)}}{10^{at/(b+t)}}\right]$$

To remove the variables, t and T, from the exponents, Equation (5) is re-written as

$$(6) \qquad \log R = \log 100 + \left[\frac{aT}{(b+T)} - \frac{at}{(b+t)}\right]$$

which becomes

$$(7) \qquad \log R = 2 + \frac{aT}{b+T} - \frac{at}{b+t}$$

Solving for T, Equation (7) becomes

$$(8) \qquad T = \frac{\frac{b \log R}{a} - \frac{2b}{a} + \frac{bt}{b+t}}{\frac{\log R}{a} + \frac{2}{a} - \frac{t}{b+t}}$$

Using Equation (8), dew points were computed for temperatures of 40°C to -40°C in 2° increments, and relative humidities of 5% to 110%, in 5% increments. Since computations could not be made assuming 0% relative humidity, computations were made for 1% relative humidity. Computations of dew-point RMS errors were made following these steps:

a. The appropriate dew point for a particular temperature and relative humidity were computed. (Let this be T.)

b. The dew points were computed for the same temperature as in a, above, but for relative humidities, one RMS smaller and one RMS larger, R-1 and R+1. (Let these be T_{-1} and T_{+1}, respectively.)

c. The absolute differences between T and T_{-1} and T and T_{+1} were determined, summed, and divided by two. The result was considered to be a representative RMS error for the temperature used and the dew point, T, which had been computed.

Here are two examples.

a. Example I:

Given: $t = 20°C$

$R_{-1} = 30\%$

$R = 35\%$

$R_{+1} = 40\%$

Computed: $T_{-1} = -0.6°C$

$T = 1.9°C$

$T_{+1} = 4.1°C$

For $T = 1.9°C$, $RMS = \frac{2.5 + 2.2}{2} = 2.4°C$.

b. Example II:

Given: $t = -10°C$

$R_{-1} = 20\%$

$R = 30\%$

$R_{+1} = 40\%$

Computed: $T_{-1} = -28.6°C$

$T = -24.2°C$

$T_{+1} = -21.0°C$

For $T = -24.2°C$, RMS $= \frac{4.4 + 3.2}{2} = 3.8°C$.

Although Equation (8) reveals that the dew-point change for any temperature is neither linear nor precisely logarithmic, this method of determining the dew-point RMS is acceptable because it is only in the highest temperatures and lowest dew points that the difference between $|T - T_{-1}|$ and $|T - T_{+1}|$ is really significant.

The computations were accomplished on the ETAC IBM 7044. The results are shown in Tables 1 and 2 for temperatures 0°C to 40°C and -40°C to 0°C, respectively. Two tables are necessary since the relative humidity RMS error is 5% for temperatures above 0°C, and 10% for temperatures 0°C to -40°C.

SECTION C — ANALYSIS

After the computations described above were completed, the RMS values, as functions of temperature and dew point, were plotted on two charts, one for temperatures 0°C to 40°C, and another for -40°C to 0°C. The dew-point RMS errors computed for 1% relative humidity were not plotted on the chart for above-freezing temperatures, and the dew-point RMS errors computed for 1% and 5% relative humidities were not plotted on the below-freezing chart. RMS isolines were then drawn on each chart. The results of the analysis are presented as nomograms.

Figure 1 is the nomogram for temperatures 0°C to 40°C; Figure 2 is for -40°C to 0°C. The diagonal lines are RMS-error isolines. The heavy diagonal line on the right of each nomogram represents temperature equal to dew point, i.e., 100% relative humidity. The portion of the nomogram to the right of this line represents supersaturated conditions. The heavy diagonal line on the left of each nomogram represents the limit of dew-point accuracy. To the left of this line, any dew points would be questionable and represents relative humidities of 5% in Figure 1 and 10% in Figure 2. RMS-error isolines

have been included in the questionable and supersaturated portions of the nomograms to assist in the interpretation near the limiting values.

Figure 3 is an example of how to use the nomograms. Assuming that a temperature of -27.2°C has been measured and a dew point of -39.6°C has been computed, the intersection of these two lines is located and found to be between the RMS-error values, 3.00 and 3.50; a RMS error of 3.4°C is read.

SECTION D — CONCLUSIONS

a. Dew-point accuracies are least (RMS errors are largest) for high temperatures and low dew points and greatest (RMS errors are smallest) for low temperatures and high dew points in each nomogram.

b. Although the dew-point RMS errors vary more or less logarithmically, linear interpolation is permissible in using the nomograms presented with this report.

REFERENCES

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[4] Mathews, Donald: Personal Communication, Equipment Development Laboratory, U.S. Weather Bureau, Washington, D. C., 22 June 1967.

[5] Saucier, W. J.: Principles of Meteorological Analysis, The University of Chicago Press, Chicago, Illinois, Third Impression, 1962.

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TABLE 1

DEW/POINT RMS ERRORS FOR TEMPERATURES 0 TO 40

TEMP = 40.			TEMP = 38.			TEMP = 36.		
RH	DPT	RMS	RH	DPT	RMS	RH	DPT	RMS
1.	-25.88	19.14	1.	-27.05	18.92	1.	-28.21	18.71
5.	-6.74	14.25	5.	-8.12	14.08	5.	-9.51	13.92
10.	2.62	7.59	10.	1.12	7.50	10.	-0.38	7.41
15.	8.45	5.07	15.	6.88	5.01	15.	5.31	4.95
20.	12.77	3.88	20.	11.14	3.83	20.	9.51	3.78
25.	16.22	3.17	25.	14.55	3.13	25.	12.87	3.09
30.	19.11	2.69	30.	17.40	2.66	30.	15.69	2.62
35.	21.61	2.35	35.	19.86	2.32	35.	18.12	2.29
40.	23.81	2.09	40.	22.04	2.06	40.	20.26	2.03
45.	25.78	1.88	45.	23.98	1.86	45.	22.18	1.83
50.	27.58	1.72	50.	25.75	1.69	50.	23.92	1.67
55.	29.22	1.58	55.	27.37	1.56	55.	25.52	1.54
60.	30.74	1.46	60.	28.87	1.44	60.	27.00	1.42
65.	32.15	1.36	65.	30.26	1.35	65.	28.37	1.33
70.	33.47	1.28	70.	31.56	1.26	70.	29.65	1.24
75.	34.71	1.21	75.	32.78	1.19	75.	30.86	1.17
80.	35.88	1.14	80.	33.93	1.12	80.	31.99	1.11
85.	36.98	1.08	85.	35.03	1.07	85.	33.07	1.05
90.	38.04	1.03	90.	36.07	1.01	90.	34.09	1.00
95.	39.04	0.98	95.	37.05	0.97	95.	35.07	0.95
100.	40.00	0.94	100.	38.00	0.93	100.	36.00	0.91
105.	40.92	0.90	105.	38.91	0.89	105.	36.89	0.87
110.	41.80	0.88	110.	39.77	0.87	110.	37.75	0.86

TEMPERATURE IS DEGREES CELSIUS
RH IS RELATIVE HUMIDITY
DPT IS DEW-POINT TEMPERATURE, DEGREES CELSIUS
RMS IS RMS ERROR OF DPT ASSUMING 5 PER CENT
ERROR IN RELATIVE HUMIDITY
RMS FOR ONE PER CENT RH NOT APPLICABLE

TABLE 1 - CONTINUED

DEW/POINT RMS ERRORS FOR TEMPERATURES 0 TO 40

TEMP = 34.			TEMP = 32.			TEMP = 30.		
RH	DPT	RMS	RH	DPT	RMS	RH	DPT	RMS
1.	-29.39	18.49	1.	-30.56	18.27	1.	-31.74	18.05
5.	-10.90	13.75	5.	-12.30	13.59	5.	-13.69	13.42
10.	-1.89	7.31	10.	-3.39	7.22	10.	-4.90	7.13
15.	3.73	4.88	15.	2.15	4.82	15.	0.57	4.75
20.	7.88	3.73	20.	6.24	3.68	20.	4.61	3.63
25.	11.19	3.05	25.	9.52	3.01	25.	7.83	2.97
30.	13.97	2.59	30.	12.26	2.55	30.	10.54	2.52
35.	16.37	2.26	35.	14.62	2.22	35.	12.87	2.19
40.	18.48	2.00	40.	16.71	1.98	40.	14.93	1.95
45.	20.38	1.81	45.	18.57	1.78	45.	16.77	1.76
50.	22.10	1.65	50.	20.27	1.62	50.	18.44	1.60
55.	23.67	1.51	55.	21.82	1.49	55.	19.97	1.47
60.	25.13	1.40	60.	23.25	1.38	60.	21.38	1.36
65.	26.48	1.31	65.	24.59	1.29	65.	22.69	1.27
70.	27.74	1.23	70.	25.83	1.21	70.	23.92	1.19
75.	28.93	1.15	75.	27.00	1.14	75.	25.08	1.12
80.	30.05	1.09	80.	28.11	1.08	80.	26.17	1.06
85.	31.11	1.04	85.	29.15	1.02	85.	27.20	1.01
90.	32.12	0.98	90.	30.15	0.97	90.	28.18	0.96
95.	33.08	0.94	95.	31.10	0.93	95.	29.11	0.91
100.	34.00	0.90	100.	32.00	0.89	100.	30.00	0.87
105.	34.88	0.86	105.	32.87	0.85	105.	30.85	0.84
110.	35.72	0.84	110.	33.70	0.83	110.	31.67	0.82

TEMPERATURE IS DEGREES CELSIUS
RH IS RELATIVE HUMIDITY
DPT IS DEW-POINT TEMPERATURE, DEGREES CELSIUS
RMS IS RMS ERROR OF DPT ASSUMING 5 PER CENT
ERROR IN RELATIVE HUMIDITY
RMS FOR ONE PER CENT RH NOT APPLICABLE

TABLE 1 - CONTINUED

DEW/POINT RMS ERRORS FOR TEMPERATURES 0 TO 40

TEMP = 28.			TEMP = 26.			TEMP = 24.		
RH	DPT	RMS	RH	DPT	RMS	RH	DPT	RMS
1.	-32.93	17.83	1.	-34.12	17.62	1.	-35.31	17.40
5.	-15.09	13.26	5.	-16.50	13.09	5.	-17.91	12.93
10.	-6.42	7.04	10.	-7.93	6.95	10.	-9.45	6.86
15.	-1.02	4.69	15.	-2.61	4.63	15.	-4.20	4.57
20.	2.97	3.59	20.	1.32	3.54	20.	-0.32	3.49
25.	6.15	2.93	25.	4.47	2.89	25.	2.78	2.84
30.	8.82	2.48	30.	7.09	2.45	30.	5.37	2.41
35.	11.12	2.16	35.	9.36	2.13	35.	7.61	2.10
40.	13.14	1.92	40.	11.36	1.89	40.	9.58	1.87
45.	14.96	1.73	45.	13.15	1.71	45.	11.34	1.68
50.	16.61	1.58	50.	14.77	1.55	50.	12.94	1.53
55.	18.11	1.45	55.	16.26	1.43	55.	14.41	1.41
60.	19.51	1.34	60.	17.63	1.32	60.	15.76	1.30
65.	20.80	1.25	65.	18.91	1.23	65.	17.01	1.22
70.	22.01	1.17	70.	20.10	1.16	70.	18.19	1.14
75.	23.15	1.10	75.	21.22	1.09	75.	19.29	1.07
80.	24.22	1.04	80.	22.28	1.03	80.	20.33	1.01
85.	25.24	0.99	85.	23.28	0.98	85.	21.32	0.96
90.	26.20	0.94	90.	24.23	0.93	90.	22.26	0.91
95.	27.12	0.90	95.	25.14	0.89	95.	23.15	0.87
100.	28.00	0.86	100.	26.00	0.85	100.	24.00	0.83
105.	28.84	0.82	105.	26.83	0.81	105.	24.82	0.80
110.	29.65	0.81	110.	27.62	0.79	110.	25.60	0.78

TEMPERATURE IS DEGREES CELSIUS
RH IS RELATIVE HUMIDITY
DPT IS DEW-POINT TEMPERATURE, DEGREES CELSIUS
RMS IS RMS ERROR OF DPT ASSUMING 5 PER CENT
ERROR IN RELATIVE HUMIDITY
RMS FOR ONE PER CENT RH NOT APPLICABLE

TABLE 1 - CONTINUED

DEW/POINT RMS ERRORS FOR TEMPERATURES 0 TO 40

TEMP = 22.			TEMP = 20.			TEMP = 18.		
RH	DPT	RMS	RH	DPT	RMS	RH	DPT	RMS
1.	-36.51	17.19	1.	-37.71	16.98	1.	-38.92	16.76
5.	-19.32	12.77	5.	-20.73	12.61	5.	-22.15	12.44
10.	-10.97	6.76	10.	-12.50	6.67	10.	-14.03	6.58
15.	-5.79	4.50	15.	-7.39	4.44	15.	-8.98	4.38
20.	-1.97	3.44	20.	-3.61	3.39	20.	-5.27	3.34
25.	1.09	2.81	25.	-0.60	2.77	25.	-2.30	2.73
30.	3.64	2.38	30.	1.92	2.35	30.	0.19	2.31
35.	5.85	2.07	35.	4.09	2.04	35.	2.33	2.01
40.	7.79	1.84	40.	6.00	1.81	40.	4.21	1.79
45.	9.53	1.66	45.	7.72	1.63	45.	5.90	1.61
50.	11.11	1.51	50.	9.27	1.49	50.	7.43	1.47
55.	12.55	1.39	55.	10.69	1.37	55.	8.83	1.35
60.	13.88	1.29	60.	12.00	1.27	60.	10.13	1.25
65.	15.12	1.20	65.	13.22	1.18	65.	11.33	1.16
70.	16.28	1.12	70.	14.36	1.11	70.	12.45	1.09
75.	17.36	1.06	75.	15.43	1.04	75.	13.51	1.02
80.	18.39	1.00	80.	16.44	0.98	80.	14.50	0.97
85.	19.36	0.95	85.	17.40	0.93	85.	15.44	0.92
90.	20.28	0.90	90.	18.31	0.89	90.	16.34	0.87
95.	21.16	0.86	95.	19.17	0.85	95.	17.19	0.83
100.	22.00	0.82	100.	20.00	0.81	100.	18.00	0.80
105.	22.80	0.79	105.	20.79	0.77	105.	18.78	0.76
110.	23.57	0.77	110.	21.55	0.76	110.	19.52	0.75

TEMPERATURE IS DEGREES CELSIUS
RH IS RELATIVE HUMIDITY
DPT IS DEW-POINT TEMPERATURE, DEGREES CELSIUS
RMS IS RMS ERROR OF DPT ASSUMING 5 PER CENT
ERROR IN RELATIVE HUMIDITY
RMS FOR ONE PER CENT RH NOT APPLICABLE

TABLE 1 - CONTINUED

DEW/POINT RMS ERRORS FOR TEMPERATURES 0 TO 40

TEMP = 16.			TEMP = 14.			TEMP = 12.		
RH	DPT	RMS	RH	DPT	RMS	RH	DPT	RMS
1.	-40.13	16.55	1.	-41.34	16.34	1.	-42.56	16.13
5.	-23.57	12.28	5.	-25.00	12.12	5.	-26.43	11.96
10.	-15.56	6.49	10.	-17.09	6.41	10.	-18.63	6.32
15.	-10.58	4.32	15.	-12.19	4.26	15.	-13.79	4.20
20.	-6.92	3.30	20.	-8.57	3.25	20.	-10.23	3.20
25.	-3.99	2.69	25.	-5.69	2.65	25.	-7.39	2.61
30.	-1.54	2.28	30.	-3.28	2.24	30.	-5.01	2.21
35.	0.56	1.98	35.	-1.20	1.95	35.	-2.97	1.93
40.	2.42	1.76	40.	0.63	1.73	40.	-1.16	1.71
45.	4.09	1.59	45.	2.27	1.56	45.	0.45	1.54
50.	5.59	1.44	50.	3.75	1.42	50.	1.91	1.40
55.	6.97	1.33	55.	5.11	1.31	55.	3.25	1.29
60.	8.25	1.23	60.	6.37	1.21	60.	4.49	1.19
65.	9.43	1.14	65.	7.53	1.13	65.	5.63	1.11
70.	10.54	1.07	70.	8.62	1.06	70.	6.71	1.04
75.	11.57	1.01	75.	9.64	0.99	75.	7.71	0.98
80.	12.55	0.95	80.	10.61	0.94	80.	8.66	0.92
85.	13.48	0.90	85.	11.52	0.89	85.	9.56	0.88
90.	14.36	0.86	90.	12.39	0.85	90.	10.41	0.83
95.	15.20	0.32	95.	13.21	0.81	95.	11.22	0.79
100.	16.00	0.78	100.	14.00	0.77	100.	12.00	0 76
105.	16.77	0.75	105.	14.75	0.74	105.	12.74	0.73
110.	17.50	0.73	110.	15.48	0.72	110.	13.45	0.71

TEMPERATURE IS DEGREES CELSIUS
RH IS RELATIVE HUMIDITY
DPT IS DEW-POINT TEMPERATURE, DEGREES CELSIUS
RMS IS RMS ERROR OF DPT ASSUMING 5 PER CENT
ERROR IN RELATIVE HUMIDITY
RMS FOR ONE PER CENT RH NOT APPLICABLE

TABLE 1 - CONTINUED

DEW/POINT RMS ERRORS FOR TEMPERATURES 0 TO 40

TEMP = 10.			TEMP = 8.			TEMP = 6.		
RH	DPT	RMS	RH	DPT	RMS	RH	DPT	RMS
1.	-43.78	15.92	1.	-45.01	15.71	1.	-46.24	15.50
5.	-27.86	11.80	5.	-29.30	11.65	5.	-30.74	11.49
10.	-20.17	6.23	10.	-21.71	6.14	10.	-23.26	6.05
15.	-15.40	4.14	15.	-17.02	4.08	15.	-18.63	4.02
20.	-11.89	3.16	20.	-13.56	3.11	20.	-15.22	3.06
25.	-9.09	2.57	25.	-10.80	2.53	25.	-12.50	2.49
30.	-6.75	2.18	30.	-8.49	2.15	30.	-10.23	2.11
35.	-4.73	1.90	35.	-6.50	1.87	35.	-8.27	1.84
40.	-2.96	1.68	40.	-4.75	1.66	40.	-6.55	1.63
45.	-1.37	1.51	45.	-3.19	1.49	45.	-5.01	1.47
50.	0.07	1.38	50.	-1.77	1.36	50.	-3.62	1.34
55.	1.39	1.27	55.	-0.47	1.25	55.	-2.34	1.23
60.	2.60	1.17	60.	0.72	1.15	60.	-1.16	1.14
65.	3.73	1.09	65.	1.83	1.08	65.	-0.07	1.06
70.	4.79	1.02	70.	2.87	1.01	70.	0.95	0.99
75.	5.78	0.96	75.	3.85	0.95	75.	1.91	0.93
80.	6.71	0.91	80.	4.77	0.89	80.	2.82	0.88
85.	7.60	0.86	85.	5.64	0.85	85.	3.67	0.83
90.	8.44	0.82	90.	6.46	0.81	90.	4.49	0.79
95.	9.24	0.78	95.	7.25	0.77	95.	5.26	0.76
100.	10.00	0.75	100.	8.00	0.73	100.	6.00	0.72
105.	10.73	0.72	105.	8.72	0.70	105.	6.71	0.69
110.	11.43	0.70	110.	9.41	0.69	110.	7.38	0.68

TEMPERATURE IS DEGREES CELSIUS
RH IS RELATIVE HUMIDITY
DPT IS DEW-POINT TEMPERATURE, DEGREES CELSIUS
RMS IS RMS ERROR OF DPT ASSUMING 5 PER CENT
ERROR IN RELATIVE HUMIDITY
RMS FOR ONE PER CENT RH NOT APPLICABLE

TABLE 1 - CONTINUED

DEW/POINT RMS ERRORS FOR TEMPERATURES 0 TO 40

TEMP = 4.			TEMP = 2.			TEMP = -0.		
RH	DPT	RMS	RH	DPT	RMS	RH	DPT	RMS
1.	-47.47	15.29	1.	-48.71	15.08	1.	-49.96	14.88
5.	-32.18	11.33	5.	-33.63	11.18	5.	-35.08	11.02
10.	-24.81	5.97	10.	-26.36	5.88	10.	-27.92	5.80
15.	-20.25	3.96	15.	-21.87	3.90	15.	-23.49	3.84
20.	-16.89	3.02	20.	-18.56	2.97	20.	-20.23	2.93
25.	-14.21	2.46	25.	-15.92	2.42	25.	-17.63	2.38
30.	-11.97	2.08	30.	-13.72	2.05	30.	-15.47	2.02
35.	-10.05	1.81	35.	-11.82	1.78	35.	-13.60	1.75
40.	-8.35	1.61	40.	-10.15	1.58	40.	-11.96	1.56
45.	-6.84	1.45	45.	-8.66	1.42	45.	-10.49	1.40
50.	-5.46	1.32	50.	-7.31	1.29	50.	-9.16	1.27
55.	-4.21	1.21	55.	-6.07	1.19	55.	-7.94	1.17
60.	-3.05	1.12	60.	-4.93	1.10	60.	-6.82	1.08
65.	-1.97	1.04	65.	-3.87	1.02	65.	-5.78	1.01
70.	-0.96	0.97	70.	-2.88	0.96	70.	-4.80	0.94
75.	-0.02	0.92	75.	-1.95	0.90	75.	-3.89	0.89
80.	0.87	0.87	80.	-1.08	0.85	80.	-3.03	0.84
85.	1.71	0.82	85.	-0.25	0.81	85.	-2.21	0.79
90.	2.51	0.78	90.	0.54	0.77	90.	-1.44	0.75
95.	3.27	0.74	95.	1.29	0.73	95.	-0.70	0.72
100.	4.00	0.71	100.	2.00	0.70	100.	0.00	0.69
105.	4.70	0.68	105.	2.68	0.67	105.	0.67	0.66
110.	5.36	0.67	110.	3.34	0.66	110.	1.32	0.64

TEMPERATURE IS DEGREES CELSIUS
RH IS RELATIVE HUMIDITY
DPT IS DEW-POINT TEMPERATURE, DEGREES CELSIUS
RMS IS RMS ERROR OF DPT ASSUMING 5 PER CENT
ERROR IN RELATIVE HUMIDITY
RMS FOR ONE PER CENT RH NOT APPLICABLE

TABLE 2

DEW/POINT RMS ERRORS FOR TEMPERATURES -40 TO 0

TEMP = 0.			TEMP = -2.			TEMP = -4.		
RH	DPT	RMS	RH	DPT	RMS	RH	DPT	RMS
1.	-49.96	14.88	1.	-51.21	14.67	1.	-52.46	14.47
5.	-35.08	11.02	5.	-36.53	10.87	5.	-37.99	10.71
10.	-27.92	14.86	10.	-29.48	14.65	10.	-31.04	14.44
15.	-23.49	8.72	15.	-25.11	8.59	15.	-26.74	8.46
20.	-20.23	6.23	20.	-21.90	6.13	20.	-23.58	6.04
25.	-17.63	4.94	25.	-19.35	4.87	25.	-21.07	4.79
30.	-15.47	4.14	30.	-17.21	4.07	30.	-18.97	4.01
35.	-13.60	3.57	35.	-15.38	3.52	35.	-17.16	3.46
40.	-11.96	3.15	40.	-13.76	3.10	40.	-15.57	3.05
45.	-10.49	2.83	45.	-12.32	2.78	45.	-14.14	2.74
50.	-9.16	2.57	50.	-11.01	2.53	50.	-12.86	2.49
55.	-7.94	2.36	55.	-9.81	2.32	55.	-11.68	2.28
60.	-6.82	2.18	60.	-8.70	2.14	60.	-10.59	2.11
65.	-5.78	2.03	65.	-7.68	1.99	65.	-9.58	1.96
70.	-4.80	1.90	70.	-6.72	1.86	70.	-8.64	1.83
75.	-3.89	1.78	75.	-5.82	1.75	75.	-7.76	1.72
80.	-3.03	1.68	80.	-4.96	1.65	80.	-6.93	1.63
85.	-2.21	1.59	85.	-4.18	1.57	85.	-6.14	1.54
90.	-1.44	1.51	90.	-3.41	1.49	90.	-5.39	1.46
95.	-0.70	1.44	95.	-2.69	1.42	95.	-4.68	1.39
100.	0.00	1.38	100.	-2.00	1.35	100.	-4.00	1.33
105.	0.67	0.66	105.	-1.34	0.65	105.	-3.35	0.64
110.	1.32	0.64	110.	-0.71	0.63	110.	-2.73	0.62

TEMPERATURE IS DEGREES CELSIUS
RH IS RELATIVE HUMIDITY
DPT IS DEW-POINT TEMPERATURE, DEGREES CELSIUS
RMS IS RMS ERROR OF DPT ASSUMING 10 PER CENT
ERROR IN RELATIVE HUMIDITY
RMS FOR ONE AND FIVE PER CENT RH NOT APPLICABLE

TABLE 2 - CONTINUED

DEW/POINT RMS ERRORS FOR TEMPERATURES -40 TO 0

TEMP = -6.			TEMP = -8.			TEMP =-10.		
RH	DPT	RMS	RH	DPT	RMS	RH	DPT	RMS
1.	-53.72	14.26	1.	-54.98	14.06	1.	-56.25	13.86
5.	-39.45	10.56	5.	-40.92	10.40	5.	-42.39	10.25
10.	-32.60	14.23	10.	-34.17	14.02	10.	-35.74	13.81
15.	-28.37	8.33	15.	-30.00	8.21	15.	-31.64	8.08
20.	-25.26	5.94	20.	-26.94	5.85	20.	-28.63	5.76
25.	-22.78	4.72	25.	-24.51	4.64	25.	-26.23	4.57
30.	-20.72	3.94	30.	-22.47	3.88	30.	-24.23	3.82
35.	-18.94	3.40	35.	-20.72	3.35	35.	-22.51	3.29
40.	-17.37	3.00	40.	-19.18	2.96	40.	-20.99	2.91
45.	-15.97	2.69	45.	-17.81	2.65	45.	-19.64	2.61
50.	-14.71	2.45	50.	-16.56	2.41	50.	-18.42	2.37
55.	-13.55	2.24	55.	-15.42	2.20	55.	-17.30	2.17
60.	-12.48	2.07	60.	-14.37	2.04	60.	-16.26	2.00
65.	-11.49	1.93	65.	-13.40	1.89	65.	-15.30	1.86
70.	-10.56	1.80	70.	-12.49	1.77	70.	-14.41	1.74
75.	-9.70	1.69	75.	-11.63	1.67	75.	-13.57	1.64
80.	-8.88	1.60	80.	-10.83	1.57	80.	-12.78	1.54
85.	-8.10	1.51	85.	-10.07	1.49	85.	-12.03	1.46
90.	-7.37	1.44	90.	-9.34	1.41	90.	-11.32	1.39
95.	-6.67	1.37	95.	-8.66	1.35	95.	-10.64	1.32
100.	-6.00	1.31	100.	-8.00	1.29	100.	-10.00	1.26
105.	-5.36	0.63	105.	-7.37	0.61	105.	-9.38	0.60
110.	-4.75	0.61	110.	-6.77	0.60	110.	-8.79	0.59

TEMPERATURE IS DEGREES CELSIUS
RH IS RELATIVE HUMIDITY
DPT IS DEW-POINT TEMPERATURE, DEGREES CELSIUS
RMS IS RMS ERROR OF DPT ASSUMING 10 PER CENT
ERROR IN RELATIVE HUMIDITY
RMS FOR ONE AND FIVE PER CENT RH NOT APPLICABLE

TABLE 2 - CONTINUED

DEW/POINT RMS ERRORS FOR TEMPERATURES -40 TO C

TEMP =-12.			TEMP =-14.			TEMP =-16.		
RH	DPT	RMS	RH	DPT	RMS	RH	DPT	RMS
1.	-57.52	13.66	1.	-58.79	13.46	1.	-60.07	13.26
5.	-43.86	10.10	5.	-45.34	9.95	5.	-46.82	9.80
10.	-37.32	13.60	10.	-38.89	13.39	10.	-40.47	13.19
15.	-33.28	7.95	15.	-34.92	7.83	15.	-36.56	7.70
20.	-30.31	5.66	20.	-32.00	5.57	20.	-33.70	5.48
25.	-27.96	4.49	25.	-29.68	4.42	25.	-31.41	4.35
30.	-25.99	3.75	30.	-27.75	3.69	30.	-29.51	3.63
35.	-24.29	3.24	35.	-26.08	3.19	35.	-27.87	3.13
40.	-22.81	2.86	40.	-24.62	2.81	40.	-26.43	2.76
45.	-21.47	2.56	45.	-23.31	2.52	45.	-25.15	2.48
50.	-20.27	2.33	50.	-22.13	2.29	50.	-23.98	2.25
55.	-19.17	2.13	55.	-21.04	2.09	55.	-22.92	2.06
60.	-18.15	1.97	60.	-20.05	1.93	60.	-21.94	1.90
65.	-17.21	1.83	65.	-19.12	1.80	65.	-21.03	1.77
70.	-16.33	1.71	70.	-18.26	1.68	70.	-20.18	1.65
75.	-15.51	1.61	75.	-17.45	1.58	75.	-19.39	1.55
80.	-14.73	1.52	80.	-16.68	1.49	80.	-18.63	1.46
85.	-14.00	1.44	85.	-15.96	1.41	85.	-17.93	1.39
90.	-13.30	1.37	90.	-15.27	1.34	90.	-17.25	1.32
95.	-12.63	1.30	95.	-14.62	1.28	95.	-16.61	1.25
100.	-12.00	1.24	100.	-14.00	1.22	100.	-16.00	1.20
105.	-11.39	0.59	105.	-13.40	0.58	105.	-15.42	0.57
110.	-10.81	0.58	110.	-12.83	0.57	110.	-14.86	0.56

TEMPERATURE IS DEGREES CELSIUS
RH IS RELATIVE HUMIDITY
DPT IS DEW-POINT TEMPERATURE, DEGREES CELSIUS
RMS IS RMS ERROR OF DPT ASSUMING 10 PER CENT
ERROR IN RELATIVE HUMIDITY
RMS FOR ONE AND FIVE PER CENT RH NOT APPLICABLE

TABLE 2 - CONTINUED

DEW/POINT RMS ERRORS FOR TEMPERATURES -40 TO 0

TEMP =-18.			TEMP =-20.			TEMP =-22.		
RH	DPT	RMS	RH	DPT	RMS	RH	DPT	RMS
1.	-61.36	13.06	1.	-62.65	12.86	1.	-63.94	12.67
5.	-48.30	9.65	5.	-49.79	9.50	5.	-51.28	9.35
10.	-42.06	12.98	10.	-43.64	12.78	10.	-45.23	12.58
15.	-38.21	7.58	15.	-39.86	7.45	15.	-41.51	7.33
20.	-35.39	5.39	20.	-37.09	5.30	20.	-38.79	5.21
25.	-33.15	4.27	25.	-34.88	4.20	25.	-36.62	4.13
30.	-31.27	3.57	30.	-33.04	3.51	30.	-34.81	3.45
35.	-29.66	3.08	35.	-31.46	3.03	35.	-33.25	2.97
40.	-28.25	2.72	40.	-30.07	2.67	40.	-31.89	2.62
45.	-26.99	2.43	45.	-28.83	2.39	45.	-30.67	2.35
50.	-25.84	2.21	50.	-27.70	2.17	50.	-29.56	2.13
55.	-24.80	2.02	55.	-26.68	1.99	55.	-28.56	1.95
60.	-23.84	1.87	60.	-25.73	1.84	60.	-27.63	1.80
65.	-22.94	1.74	65.	-24.85	1.71	65.	-26.76	1.68
70.	-22.11	1.62	70.	-24.03	1.59	70.	-25.96	1.57
75.	-21.32	1.53	75.	-23.26	1.50	75.	-25.21	1.47
80.	-20.59	1.44	80.	-22.54	1.41	80.	-24.49	1.39
85.	-19.89	1.36	85.	-21.86	1.34	85.	-23.82	1.31
90.	-19.23	1.29	90.	-21.21	1.27	90.	-23.19	1.25
95.	-18.60	1.23	95.	-20.59	1.21	95.	-22.58	1.19
100.	-18.00	1.18	100.	-20.00	1.16	100.	-22.00	1.13
105.	-17.43	0.56	105.	-19.44	0.55	105.	-21.45	0.54
110.	-16.88	0.55	110.	-18.90	0.54	110.	-20.92	0.53

TEMPERATURE IS DEGREES CELSIUS
RH IS RELATIVE HUMIDITY
DPT IS DEW-POINT TEMPERATURE, DEGREES CELSIUS
RMS IS RMS ERROR OF DPT ASSUMING 10 PER CENT
ERROR IN RELATIVE HUMIDITY
RMS FOR ONE AND FIVE PER CENT RH NOT APPLICABLE

TABLE 2 - CONTINUED

DEW/POINT RMS ERRORS FOR TEMPERATURES -40 TO 0

TEMP =-24.			TEMP =-26.			TEMP =-28.		
RH	DPT	RMS	RH	DPT	RMS	RH	DPT	RMS
1.	-65.24	12.47	1.	-66.55	12.27	1.	-67.85	12.08
5.	-52.77	9.21	5.	-54.27	9.06	5.	-55.77	8.92
10.	-46.83	12.38	10.	-48.42	12.18	10.	-50.02	11.98
15.	-43.17	7.21	15.	-44.83	7.09	15.	-46.49	6.97
20.	-40.49	5.12	20.	-42.19	5.04	20.	-43.90	4.95
25.	-38.36	4.06	25.	-40.10	3.99	25.	-41.84	3.92
30.	-36.58	3.39	30.	-38.35	3.33	30.	-40.12	3.27
35.	-35.05	2.92	35.	-36.85	2.87	35.	-38.65	2.82
40.	-33.71	2.58	40.	-35.53	2.53	40.	-37.36	2.48
45.	-32.51	2.31	45.	-34.36	2.27	45.	-36.20	2.22
50.	-31.43	2.09	50.	-33.29	2.05	50.	-35.16	2.02
55.	-30.44	1.92	55.	-32.32	1.88	55.	-34.20	1.85
60.	-29.52	1.77	60.	-31.42	1.74	60.	-33.32	1.71
65.	-28.68	1.65	65.	-30.59	1.62	65.	-32.51	1.59
70.	-27.89	1.54	70.	-29.82	1.51	70.	-31.74	1.48
75.	-27.15	1.44	75.	-29.09	1.42	75.	-31.03	1.39
80.	-26.45	1.36	80.	-28.40	1.34	80.	-30.36	1.31
85.	-25.79	1.29	85.	-27.76	1.27	85.	-29.72	1.24
90.	-25.16	1.22	90.	-27.14	1.20	90.	-29.12	1.18
95.	-24.57	1.17	95.	-26.56	1.14	95.	-28.55	1.12
100.	-24.00	1.11	100.	-26.00	1.09	100.	-28.00	1.07
105.	-23.46	0.53	105.	-25.47	0.52	105.	-27.48	0.51
110.	-22.94	0.52	110.	-24.96	0.51	110.	-26.98	0.50

TEMPERATURE IS DEGREES CELSIUS
RH IS RELATIVE HUMIDITY
DPT IS DEW-POINT TEMPERATURE, DEGREES CELSIUS
RMS IS RMS ERROR OF DPT ASSUMING 10 PER CENT
ERROR IN RELATIVE HUMIDITY
RMS FOR ONE AND FIVE PER CENT RH NOT APPLICABLE

TABLE 2 - CONTINUED

DEW/POINT RMS ERRORS FOR TEMPERATURES -40 TO 0

TEMP =-30.			TEMP =-32.			TEMP =-34.		
RH	DPT	RMS	RH	DPT	RMS	RH	DPT	RMS
1.	-69.17	11.89	1.	-70.49	11.69	1.	-71.81	11.50
5.	-57.28	8.77	5.	-58.79	8.63	5.	-60.30	8.48
10.	-51.63	11.78	10.	-53.23	11.58	10.	-54.84	11.39
15.	-48.15	6.85	15.	-49.82	6.73	15.	-51.49	6.61
20.	-45.61	4.86	20.	-47.32	4.78	20.	-49.03	4.69
25.	-43.58	3.85	25.	-45.33	3.78	25.	-47.08	3.71
30.	-41.90	3.21	30.	-43.68	3.15	30.	-45.46	3.10
35.	-40.45	2.77	35.	-42.26	2.72	35.	-44.06	2.67
40.	-39.18	2.44	40.	-41.01	2.39	40.	-42.84	2.35
45.	-38.05	2.18	45.	-39.90	2.14	45.	-41.75	2.10
50.	-37.02	1.98	50.	-38.89	1.94	50.	-40.76	1.91
55.	-36.09	1.81	55.	-37.97	1.78	55.	-39.86	1.75
60.	-35.22	1.67	60.	-37.12	1.64	60.	-39.02	1.61
65.	-34.42	1.56	65.	-36.34	1.53	65.	-38.25	1.50
70.	-33.67	1.45	70.	-35.60	1.43	70.	-37.53	1.40
75.	-32.97	1.37	75.	-34.92	1.34	75.	-36.86	1.31
80.	-32.31	1.29	80.	-34.27	1.26	80.	-36.23	1.24
85.	-31.69	1.22	85.	-33.66	1.20	85.	-35.63	1.17
90.	-31.10	1.16	90.	-33.08	1.13	90.	-35.06	1.11
95.	-30.54	1.10	95.	-32.53	1.08	95.	-34.52	1.06
100.	-30.00	1.05	100.	-32.00	1.03	100.	-34.00	1.01
105.	-29.49	0.50	105.	-31.50	0.49	105.	-33.51	0.48
110.	-29.00	0.49	110.	-31.02	0.48	110.	-33.03	0.47

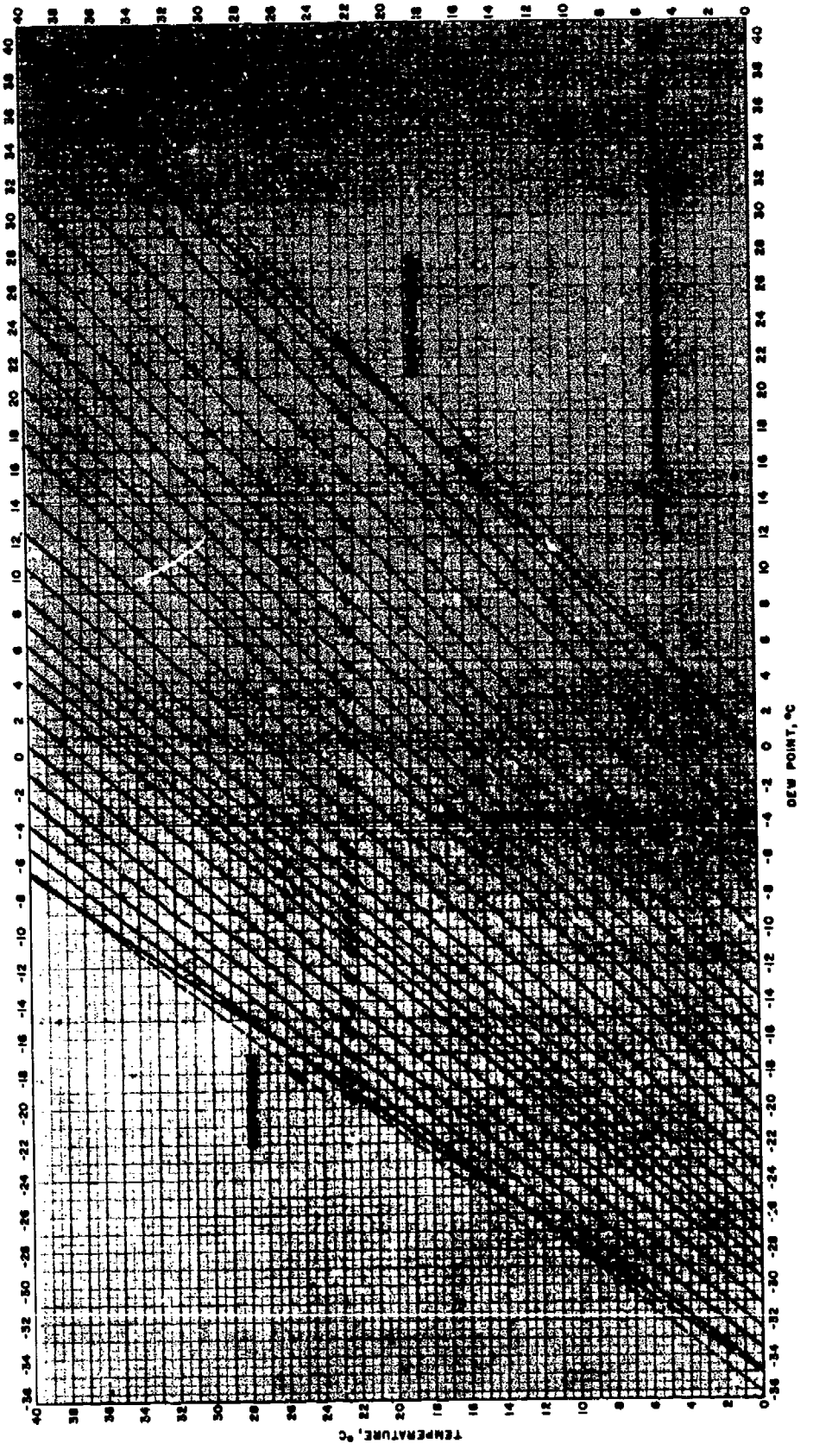
TEMPERATURE IS DEGREES CELSIUS
RH IS RELATIVE HUMIDITY
DPT IS DEW-POINT TEMPERATURE, DEGREES CELSIUS
RMS IS RMS ERROR OF DPT ASSUMING 10 PER CENT
ERROR IN RELATIVE HUMIDITY
RMS FOR ONE AND FIVE PER CENT RH NOT APPLICABLE

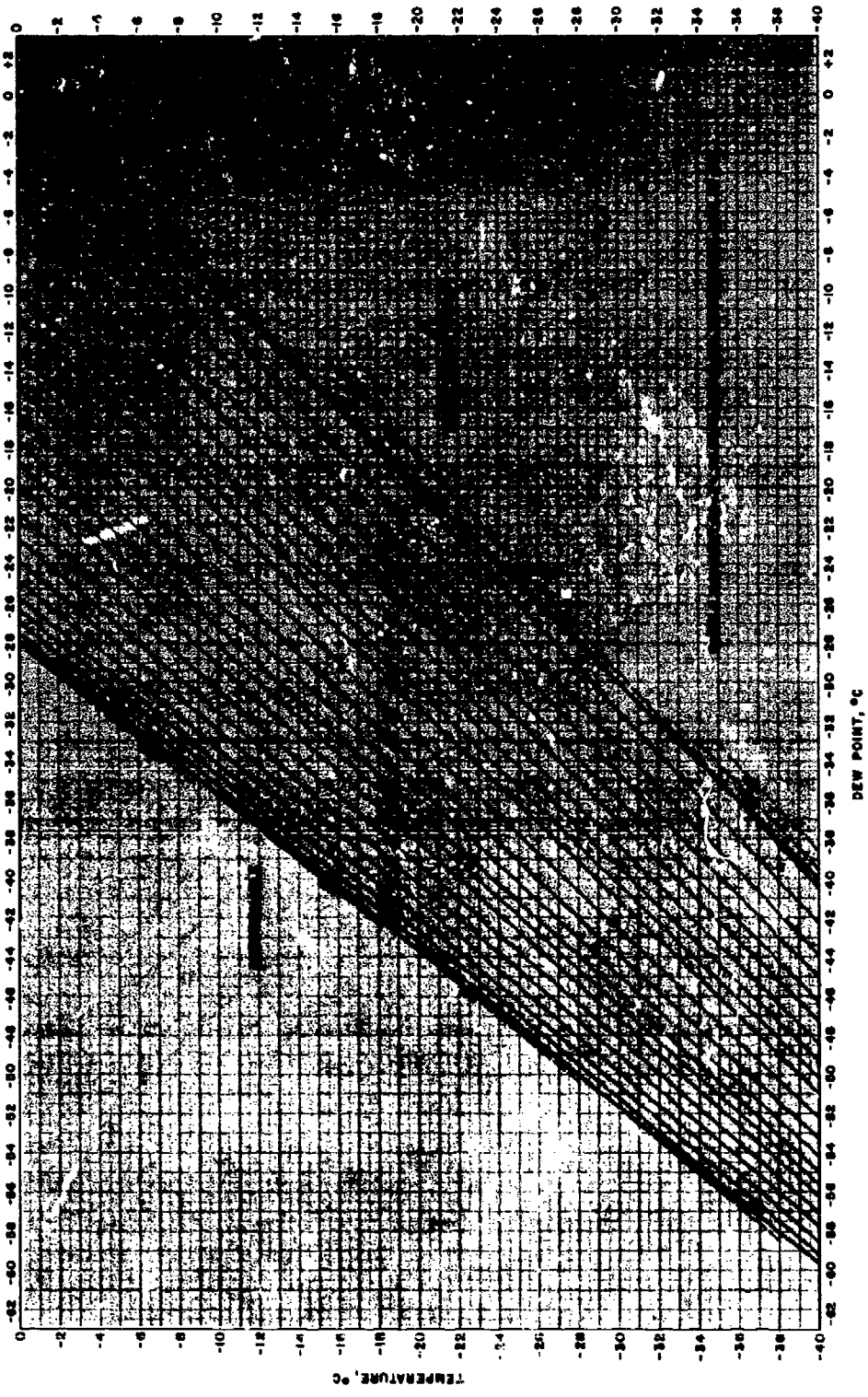
TABLE 2 - CONTINUED

DEW/POINT RMS ERRORS FOR TEMPERATURES -40 TO 0

TEMP =-36.			TEMP =-38.			TEMP =-40.		
RH	DPT	RMS	RH	DPT	RMS	RH	DPT	RMS
1.	-73.14	11.31	1.	-74.47	11.12	1.	-75.81	10.94
5.	-61.82	8.34	5.	-63.34	8.20	5.	-64.87	8.06
10.	-56.45	11.19	10.	-58.07	11.00	10.	-59.69	10.81
15.	-53.16	6.49	15.	-54.83	6.38	15.	-56.51	6.26
20.	-50.75	4.61	20.	-52.47	4.52	20.	-54.19	4.44
25.	-48.83	3.64	25.	-50.59	3.58	25.	-52.34	3.51
30.	-47.24	3.04	30.	-49.02	2.98	30.	-50.81	2.93
35.	-45.87	2.62	35.	-47.68	2.57	35.	-49.49	2.52
40.	-44.67	2.31	40.	-46.50	2.26	40.	-48.34	2.22
45.	-43.60	2.06	45.	-45.45	2.03	45.	-47.30	1.99
50.	-42.63	1.87	50.	-44.50	1.84	50.	-46.37	1.80
55.	-41.74	1.71	55.	-43.63	1.68	55.	-45.52	1.65
60.	-40.93	1.58	60.	-42.83	1.55	60.	-44.74	1.52
65.	-40.17	1.47	65.	-42.09	1.44	65.	-44.01	1.41
70.	-39.47	1.37	70.	-41.40	1.35	70.	-43.33	1.32
75.	-38.80	1.29	75.	-40.75	1.26	75.	-42.70	1.24
80.	-38.18	1.21	80.	-40.14	1.19	80.	-42.10	1.17
85.	-37.59	1.15	85.	-39.56	1.13	85.	-41.53	1.10
90.	-37.04	1.09	90.	-39.02	1.07	90.	-41.00	1.05
95.	-36.51	1.04	95.	-38.50	1.02	95.	-40.49	1.00
100.	-36.00	0.99	100.	-38.00	0.97	100.	-40.00	0.95
105.	-35.52	0.47	105.	-37.53	0.46	105.	-39.54	0.45
110.	-35.05	0.46	110.	-37.07	0.45	110.	-39.09	0.44

TEMPERATURE IS DEGREES CELSIUS
RH IS RELATIVE HUMIDITY
DPT IS DEW-POINT TEMPERATURE, DEGREES CELSIUS
RMS IS RMS ERROR OF DPT ASSUMING 10 PER CENT
ERROR IN RELATIVE HUMIDITY
RMS FOR ONE AND FIVE PER CENT RH NOT APPLICABLE


DEW POINT, °C
TEMPERATURE, °C


TEMPERATURE, °C
DEW POINT, °C

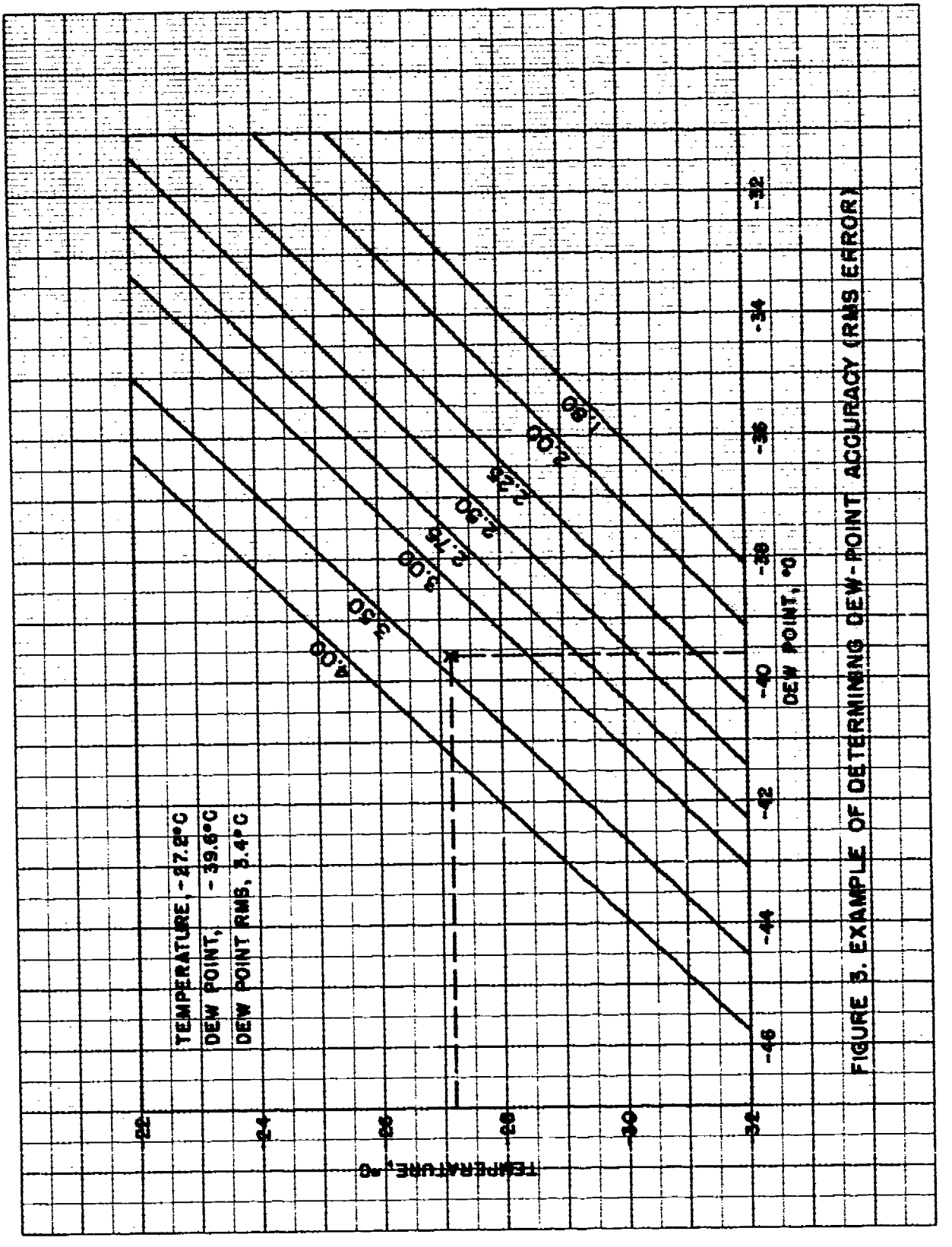


FIGURE 3. EXAMPLE OF DETERMINING DEW-POINT ACCURACY (RMS ERROR)

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13. ABSTRACT

In most of the literature, accuracies for radiosonde-measured atmospheric moisture are expressed in terms of relative humidity, i.e., the percent of saturation. This report presents the radiosonde-measured atmospheric moisture accuracies in terms of dew point, i.e., saturation temperature. The dew-point root-mean-square (RMS) errors are presented in tables which resulted from the computations and in nomograms for ready use. A table and a nomogram are included for temperatures between 0°C and 40°C, and another of each for temperatures between -40°C and 0°C. Dew-point accuracies are least for high temperatures and low dew points and greatest for low temperatures and high dew points in each temperature group, viz., 0°C to 40°C and -40°C to 0°C.

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Radiosonde						
Dew-point accuracies						
Radiosonde dew-point accuracies						
Root-mean-square (RMS) error						
Dew-point RMS error						
Atmospheric moisture						
Relative humidity						
Dew point						

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